International Journal of Plant & Soil Science

Volume 36, Issue 1, Page 131-139, 2024; Article no.IJPSS.111786
ISSN: 2320-7035

Effect of Organic Sources of Nutrients on Growth and Flowering of Spray Chrysanthemum

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Authors' contributions

This work was carried out in collaboration among all authors. Author SS designed the study, did data acquisition and analysis. Author IS conceptualized the study, did data curation and investigated the study. Authors DS, SM and RC wrote, reviewed and edited the manuscript and helped in conceptualization. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2024/v36i14338

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/111786

Original Research Article

Received: 04/11/2023
Accepted: 10/01/2024
Published: 16/01/2024

ABSTRACT

Aims: Chrysanthemum (*Dendranthema grandiflora* Tzvelev) also known as "Queen of the East" is one of the most imperative and the oldest flowering plant which is grown all over the world. Organic manures and bio-fertilizers improve soil health by increasing soil microorganisms and it helps the easy uptake of nutrients when crop is required to make it from unavailable form to available form. The present study was conducted to identify the best organic sources of nutrients for quality flower production of Chrysanthemum var. Aparajita.

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Experimental Design: The experiment was laid out in RCBD (Randomized Completely Block Design) where treatments comprised with control and application of enriched FYM, enriched Vermicompost, enriched poultry manures as well as spraying with seaweeds extract singly and/or in combination as per the treatment.
Place and Duration of the Experiment: The present investigation was carried out at Instructional Farm, Department of Floriculture, Medicinal and Aromatic Plants in Uttar Banga Krishi Viswavidyalaya in the year of 2018-2020. The place is situated in Terai Region of West Bengal at 26^0 19 N latitude and 89^0 23 E longitude.
Results: The results revealed that application of enriched FYM @ 12.5t/ha+ enriched vermicompost @ 2.5t/ha + Seaweeds extract spraying @ 3 ml/l (T_{11}) recorded maximum plant height (46.19 cm), plant spread (E-W: 26.54 cm and N-S: 26.72 cm), production of more number of primary branches (7.25) and leaves per plant (105.33), minimum days taken to first flower bud initiation (68.13 days) and first flower full blooming (10.11 days), more number of flowers per plant (35.16), vase life (14.55 days) in tap water, maximum Gross return (Rs. 517957.00 per ha) and B:C ratio (1:2.53) while minimum was recorded in control (T_1) as compare to other treatments.
Conclusion: Based on the experiment, it had been concluded that application of enriched FYM @ 12.5t/ha+ enriched vermicompost @ 2.5t/ha + Seaweeds extract spraying @ 3 ml/l in combination was the best for organic cultivation of spray Chrysanthemum in the Terai region of West Bengal which was also economically viable for poor and marginal farmers of West Bengal.

Keywords: Enriched organic manures; seaweeds extract; spray chrysanthemum.

ABBREVIATIONS

Cm : Centimetre
G : Gram
FYM : Farm Yard Manures
CD : Critical Differences
CV : Cumulative Variances

1. INTRODUCTION

Chrysanthemum is one of the most imperative and the oldest flowering plant which is grown all over the world. It has wide range of shapes, sizes and colour of flowers and having long lasting florets that's why it is preferred. Chrysanthemum (*Dendranthema grandiflora* Tzvelev) also known as "Queen of the East" [1] and belongs to the family Asteraceae. After the industrial and green revolution, use of inorganic fertilizers has been increased which leads to a decline in the usage of organic fertilizers. Chemical fertilizers have an important role in increasing agricultural yield by 50-60%, but their continuous usage not only harms soil health and the environment, but also diminishes crop output [2]. With the increase in populations, aim should not be stabilizing the production but also enhance it in a sustainable manner. Therefore, nowadays, attention is shifted towards the alternate sources of fertilizers *i.e.* organic sources of nutrients and bio-fertilizers. Organic manures are easily available and the cost is less than inorganic fertilizers. Organic manures and bio-fertilizers improve soil health by increasing soil microorganisms and it helps the easy uptake of nutrients when crop required it by make it from unavailable form to available form [3]. In modern Floriculture, new techniques have been developed to obtain good quality bloom with sufficient quantity. One among such approaches is the usage of "bio-stimulants" which have been emerged as a supplement to mineral fertilizer and improved the yield as well as quality of blooms [4,5]. Now a days, the use of enriched organic sources of nutrients occupied an important place as they provide a scope for reduction in use of chemical fertilizers which can pollute the soil if long term used [6]. Bio-fertilizers are low cost and renewable organic sources of plant nutrients that ensure slow release of nutrient throughout the crop growth period and also used to supplement chemical fertilizers [7]. Use of bio-fertilizers reduces per unit requirement of chemical fertilizers and improves quality as well as quantity of the blooms [8]. It has been reported that vegetative growth of China aster was increased due to increasing level of vermi-compost [9]. With the addition of bio-fertilizer to the growing media, duration of flowering in gladiolus, number of florets per spike, size of floret and vase life improved [10]. In dahlia, maximum plant height, number of primary brunches, number of leaves per plant, plant spread, a greater number of flowers are obtained due to the use of enriched vermicompost [11]. Many researchers emphasized the beneficial impacts of organic fertilizers on growth and flower production in

China aster [12-13]. Enriched Vermi-compost, an organic fertilizer contains N, P, K, micronutrients and beneficial soil microbes (nitrogen fixing and phosphate solubilizing bacteria and actinomycetes), and alternative to chemical fertilizers, which is also act as a growth promoter and protector of plants [14,15,16]. Maximum grain yield of maize obtained by the application of enriched FYM [17]. It has been reported that vegetative growth and fruit yield was increased due to the application of enriched vermi-compost and poultry manure [17]. Sea weed manures rich in potassium [18] and extracts contain growth promoting hormones (IBA, IAA, Cytokinin), trace elements (Fe, Cu, Zn, Co, Mo, Mn, Ni), vitamins antibiotics and amino acid [19,20,21]. In China aster flower quality, shelf life and vase life were recorded maximum by the application of bio-vita @ 1% [22]. In Chrysanthemum, maximum number of leaves, leaf area per plants, number of primary and secondary brunches was recorded by the application of bio-vita @ 0.6% [23]. Keeping in view the importance of organic manures and bio-stimulants, the present study was undertaken to find out the effect of organic manure and bio-inoculants on vegetative and flowering parameter of spray Chrysanthemum under open field condition in Terai region of West Bengal.

2. MATERIALS AND METHODS

2.1 Experimental Site

The present investigation was carried out at Instructional Farm, Department of Floriculture, Medicinal and Aromatic Plants in Uttar Banga Krishi Viswavidyalaya.The place is situated in Terai Region of West Bengal at 26^0 19 N latitude and 89^0 23 E longitude. The sites lie in the sub-Himalayan plains at an elevation of 43 meters above mean sea level. This zone is marked by a typical sub-tropical climate with high relative humidity, moderate temperature, high annual rainfall (3000 mm) and prominent winter.

2.2 Experimental Treatments

For this experiment a chrysanthemum variety named Aparajita was used, which was a spray flowering chrysanthemum. The treatments were T_1- control, T_2- Enriched Farm Yard Manures (FYM) @ 25ton/ha, T_3-Enriched Vermi-compost @ 5ton/ha, T_4- Enriched Poultry Manure @ 5ton/ha, T_5- Enriched FYM@ 12.5ton/ha+ Enriched Vermi-compost @ 2.5ton/ha, T_6- Enriched FYM @ 12.5ton/ha+ Enriched Poultry Manure @ 2.5ton/ha, T_7- Enriched Vermi-compost @ 2.5ton/ha+ Enriched Poultry Manure @ 2.5ton/ha, T_8- Enrich Vermi-compost @ 2.5ton/ha+ Sea weeds extract @ 3ml/l /foliar spray, T_9- Enriched Poultry Manure @ 2.5ton/ha + Sea weeds extract @ 3ml/l/ foliar spray, T_{10}- Enriched FYM @ 12.5ton/ha + Enriched Vermi-compost @ 2.5ton/ha + Enriched Poultry Manure @ 2.5ton/ha, T_{11}- Enriched FYM @ 12.5ton/ha + Enriched Vermi-compost @ 2.5ton/ha + Seaweeds extract @ 3ml/l/ foliar spray, T_{12}- Enriched Vermi-compost @ 2.5ton/ha + Enriched Poultry Manure @ 2.5ton/ha + Sea weeds extract @ 3ml/l/foliar spray, T_{13}- Enriched FYM @ 12.5ton/ha+ Enriched Poultry Manure @2.5ton/ha + Seaweeds extract @3ml/l/foliar spray, T_{14}- Enriched FYM @ 12.5ton/ha + Enriched Vermi-compost @ 2.5ton/ha + Enriched Poultry Manure @ 2.5ton/ha + Sea weeds extract @ 3ml/l/ foliar spray.

2.3 Planting

One-month old rooted cuttings were transplanted at a spacing of 40 cm x 30 cm with 25 plants in each plot. Enriched organic manures were applied in two equal splits as basal and top dressing. First dose was applied @ ½ of the total doses as basal at 20 days before transplanting and rest 1/2 was divided in two equal splits doses and applied as top dressing viz. 30 and 60 days after transplanting. The soil of the experimental field was sandy loam with poor water holding capacity and poor fertility status. Soil has high residual moisture content and pH was acidic in nature (5.61). Observations on growth, flowering and postharvest attributes were recorded. The experimental data subjected to analysis of variance and critical difference were calculated to compare the means by following Randomized Completely Block Design [24].

2.4 Statistical Analysis

The experiment was laid out in RCBD (Randomized Completely Block Design) with three replications and fourteen treatments during the cropping season from September 2019 to February 2020. Statistical analysis was done in OP STAT (Operational statistics) software.

3. RESULTS AND DISCUSSION

The results presented in the Table 1. revealed that the application of enriched FYM @12.5t/ha + enriched vermicompost @2.5t/ha + Seaweeds extracts @ 3ml/l (T_{11}) recorded maximum plant height (46.19 cm), maximum plant spread (E-W:

26.54& N-S: 26.72 cm), no. of primary branches per plant (7.25), no. of secondary branches per plant (9.00), no. of leaves per plant (105.33) followed by T_3 and T_2 while maximum leaf area was recorded in T_3 (17.25 cm^2). This might be due to the application of enriched organic manures along with biostimulants. Enriched FYM, enriched vermi-compost along with Sea weeds Extract could have accelerate the nitrogen mineralization process that ensured slow but steady release of essential nutrients throughout the crop growth period and promoted higher plant height and plant spread at the time of flowering. Similar results were reported by Verma et al. [25] in Chrysanthemum. The greater number of branches produced per plant might be due to slow but steady release of essential micro and macro nutrients and growth promoting substances to the plant throughout the growth period. There by it might be favoured for production and stimulation of auxiliary buds resulting in formation of higher number of branches per plant. These results were supported by Kale et al. [26] in Salvia and Nethra [27] in China aster. Maximum no. of leaves per plant and leaf area were produced might be due to application of organic manures in combination with bio-fertilizers and bio-stimulants would have ensured balance nutrients in an optimum level that helped in plant metabolism through the slow but steady supply of micro nutrients, which encouraged vigorous plant growth and in enriched vermicompost the growth promoting substances present in bio-fertilizer might have enhanced the plant growth and helped to fixing the atmospheric nitrogen and mobilizing the soil phosphorous content. All these might have helped in production of a greater number of leaves and higher leaf area. These results were supported by Saha [28] in Lettuce, Kumar et al. [29] in African marigold and Naik [30] in carnation.

The results of phenological parameters, graphically represented in the Fig. 1. revealed that application of enriched FYM @12.5t/ha+ enriched vermicompost @ 2.5t/ha + Seaweeds extracts @ 3ml/l (T_{11}) recorded minimum days taken to first flower bud open (23.22 days), days taken to firstflower full blooming (10.11 days), maximum days taken to first flower wilting (18.22 days) followedby T_3 and T_2. The results revealed that early bud initiation, flower opening, full blooming and delay in wilting might be due to the effect of enriched vermi-compost along with FYM and Seaweeds extract containing enzymes like amylase, lipase, cellulose which continue to release the essential nutrients and make it available for root absorption. They also helped to increase some soil enzymes like Urease, dehydrogenase, alkaline phosphate. Urease helps in N- cycle because it hydrolyses urea and enzyme phosphate convert soil phosphorous into bio-available form for plants absorption. These results might also be due to the gibberellins acid present in vermi-compost which associated with the regulation of flowering. These findings were strongly agreed with works of Vetal et al. [31] in lillium, Yagi et al. [32] in zinnia. *Azotobacter* and PSB might have indirect role which make the nutrient readily available throughout the growth period and along with growth promoting substances which associated with the regulation of flowering. These findings are in corroboration with the work Naik et al. [33] in marigold and Khanna et al. [34] in China aster.

Treatment T_{11} recorded more no. of flowers per plant (35.16), no. of flowers per plot (879.16), Vase life (14.55 days), field life (16.10 days) while minimum was recorded in treatment T_1 as compare to other treatments. Treatment T_3 (enriched vermicompost @ 5t/ha) recorded maximumleaf area (17.25 cm^2), stalk length (6.46 cm), flower weight (1.12 g), flower diameter (3.36 cm) ascompare to other treatments presented in the Table 2. The treatment T_{11} produced more. No. of flower perplant and more no. of flowers per plot might be due to the combined application of enriched manures along with bio-stimulants. Plant growth promoting substances present in bio-fertilizer like gibberellins, IAA, vitamin, riboflavins might have enhanced the soil fertility by increasing the availability of plant nutrients. Combined application of bio-fertilizers and organic manures might have enhanced root and shoot development, thereafter it might have influenced the reproductive phase and induced flowering which finally resulted in a greater number of flowers per plant and per plot. Similar findings were reported by Thumar et al. [35], Patel et al. [36] in Marigold and Airadevi and Mathad [37]. in garland Chrysanthemum. Increased flower diameter might be due to the effect of vermi-compost along with bio-fertilizer. PSB has the ability to bring insoluble phosphate into soluble form by releasing organic acid which can also helps to improve flower diameter. Similar results have been found by Thumar et al. [35] in Marigold. From the present study, it was clear that increased flower diameter might be due to the effect of vermi-compost along with PSB and *Azotobacter.* It might also be due to better uptake of essential macro and micro

Table 1. Effect of organic sources of nutrients on growth attributes of spray Chrysanthemum

Treatments	Plant height 30DAP (cm)	Plant height at the time of flowering (cm)	Plant spread 30DAP (cm)		Plant spread at flowering (cm)		Number of primary branches per plant	Number of secondary branches per plant	Number of leaves at the time of flowering	Leaf area (cm^2) at the time of flowering
			E-W	N-S	E-W	N-S				
T_1	5.70	27.34	3.54	3.63	13.54	12.65	4.08	4.16	59.41	7.76
T_2	12.64	42.44	7.77	8.13	24.80	24.30	6.66	7.16	96.50	13.53
T_3	12.77	43.60	9.81	9.52	24.84	25.18	6.83	7.58	101.33	17.25
T_4	7.66	33.25	5.81	5.93	21.79	20.96	5.83	6.50	73.25	9.87
T_5	6.72	30.54	4.50	3.84	16.15	14.59	4.91	5.50	68.75	8.78
T_6	10.54	39.63	7.52	7.67	23.41	22.39	6.25	6.41	88.41	11.84
T_7	7.12	30.94	5.70	6.48	19.89	17.33	4.75	5.31	65.66	8.61
T_8	11.90	41.47	8.50	8.12	24.02	22.58	6.50	7.08	92.91	12.91
T_9	6.57	28.69	3.95	3.85	14.18	15.10	4.25	4.41	61.16	8.38
T_{10}	9.00	36.44	6.77	6.62	22.34	20.98	5.33	5.75	77.75	10.45
T_{11}	14.74	46.19	10.69	9.72	26.54	26.72	7.25	9.00	105.33	15.91
T_{12}	9.59	38.40	6.62	7.06	21.30	22.68	6.08	6.33	84.25	10.80
T_{13}	8.66	38.15	6.79	6.67	20.77	22.70	5.83	6.33	82.83	10.69
T_{14}	7.38	32.06	5.58	5.71	19.67	20.34	5.00	5.50	71.66	9.29
Mean	9.35	36.36	6.68	6.63	20.94	20.61	5.68	6.21	80.65	11.15
CD at 5%	1.39	4.86	1.13	1.14	2.55	2.81	1.86	1.63	3.54	0.89
SE(m)±	0.47	1.66	0.38	0.39	0.87	0.96	0.63	0.55	1.21	0.30
SE(d)	0.67	2.35	0.54	0.55	1.23	1.36	0.90	0.78	1.71	0.43
C.V.	8.81	7.92	10.04	10.24	7.23	8.08	19.46	15.54	2.60	4.76

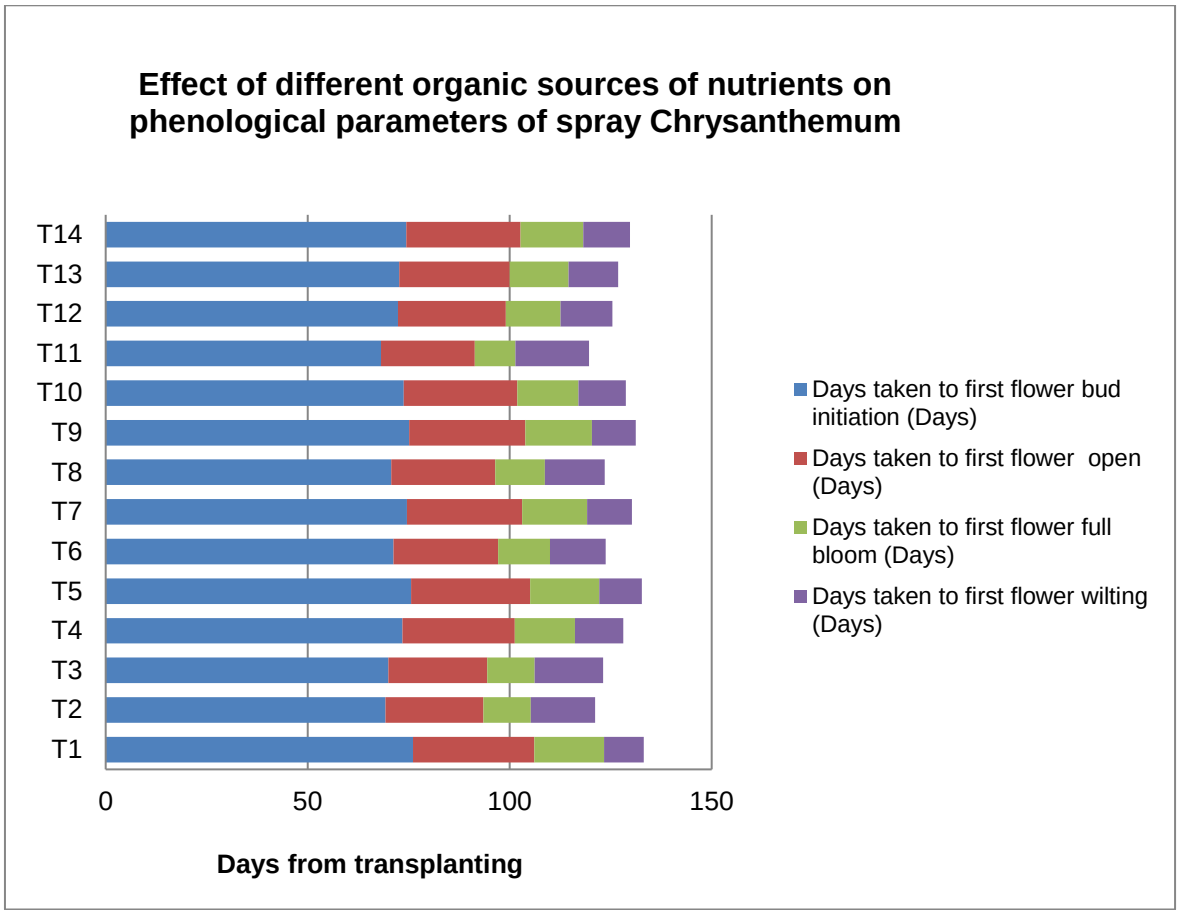

Fig. 1. Effect of organic sources of nutrients on phenological parameters of spray chrysanthemum

**0 days means transplanting day of the seedlings*

Table 2. Effect of organic sources of nutrients on flowering parameters of chrysanthemum

Treatmens	Stalk lengh (cm)	Flower diameter (cm)	Field life (Days)	Number of flowers per plant	Number of flowers per plot	Vase life (days)	Flower weight (g)
T_1	3.73	2.74	7.41	15.16	379.16	5.83	0.57
T_2	6.24	3.32	14.28	33.70	842.66	12.75	1.10
T_3	6.46	3.36	14.77	32.66	816.66	13.44	1.12
T_4	5.27	3.02	11.00	23.83	595.83	9.14	0.85
T_5	3.73	2.85	9.66	21.15	528.75	7.92	0.71
T_6	5.35	3.15	13.29	30.75	768.75	11.79	0.93
T_7	4.23	2.81	8.54	20.25	506.25	7.75	0.70
T_8	5.45	3.23	13.52	31.23	780.83	12.23	1.02
T_9	4.27	2.78	7.80	19.08	477.08	6.58	0.61
T_{10}	5.01	2.96	11.63	22.87	571.83	13.26	0.84
T_{11}	5.96	3.26	16.10	35.16	879.16	14.55	1.04
T_{12}	5.32	3.12	12.17	28.66	716.66	10.47	0.90
T_{13}	5.30	3.06	11.89	25.98	649.58	10.31	0.86
T_{14}	4.90	2.92	9.83	22.66	566.66	8.93	0.75
Mean	5.08	3.04	11.56	26.15	653.91	10.35	0.857
CDat 5%	0.54	0.02	0.63	1.92	48.21	2.73	0.016
SE(m)±	0.18	0.00	0.21	0.66	16.49	0.93	0.005
SE(d)	0.26	0.01	0.309	0.93	23.32	1.32	0.008
C.V.	6.29	0.38	3.27	4.36	4.36	15.63	1.10

Table 3. Effect of different organic manures on economics of organic cultivation of chrysanthemum

Treatments	Total cost of cultivation/ha (Rs.)	Gross return (Rs.) /ha	Net Return (Rs.) /ha	B:C ratio
T_1	81966	210455	128489	1:1.56
T_2	146466	500096	353630	1:2.41
T_3	145966	485842	339876	1:2.32
T_4	123466	342886	219420	1:1.77
T_5	110466	298948	188482	1:1.70
T_6	143466	446822	303356	1:2.11
T_7	1045466	282868	177402	1:1.68
T_8	145196	455908	310712	1:2.13
T_9	102196	266300	164104	1:1.60
T_{10}	119716	328663	208947	1:1.74
T_{11}	146746	517957	371211	1:2.53
T_{12}	140446	414997	274551	1:1.95
T_{13}	132446	374289	241843	1:1.86
T_{14}	118696	322015	203319	1:1.71

** Treatments details are described in Materials and methods*
** Selling of Chrysanthemum: 50% as loose flower @ Rs.60/-per kg*
** Selling price of 50% Chrysanthemum flower @ Rs30/-per bunch (70 flowers in a bunch)*

nutrients, photosynthetic efficiency, excellent physiological and bio chemical activities in the presence of PSB and *azotobacter.* Similar findings were also reported by Gangadharan and Gopinath [38] in Gladiolus and Bhalla et al. [10] in Carnation.

The field life of flowers was significantly differed as because single and combination effect of organic sources of nutrients. It might be xylem and phloem activity within the plants. Increased flower weight, field life and vase life were might be due to the effect of vermi-compost which rich in humus along with PSB and *azotobacter* and also contain essential plant nutrients, vitamins, micro-organisms and enzymes. It helps for long term availability of nutrients for plants. Similar findings were reported by Hemavathi [39] in Chrysanthemum, Godse et al. [40] in Gladiolus.

Treatment T_{11} also recorded maximum Gross return (Rs 517957.00/ha), net return (Rs.371211.00/ha), B:C ratio (1:2.53) and minimum was recorded in T_1 (control) and presented in Table 3. Production of a greater number of flowers might be due to the combined application of Enriched manures along with bio-stimulants that ensured steady but slow release of essential nutrients throughout the crop growth period.

4. CONCLUSION

This is clear from the investigation that application of enriched FYM and vermi-compost as basal (@6.25 t/ha and 1.25t/ha respectively) and top dressing (@6.25 t/ha and 1.25t/ha respectively in each split) and foliar application of seaweed extract (@ 3 ml/l) at three consecutive interval showed better performance of chrysanthemum in respect of morphological, quality and yield attributes. The best qualitative and quantitative traits of spray chrysanthemum var. Aparajita have been achieved with the treatment due to availability of macro and micro nutrients and which ensured steady but slow release of essential nutrients as and when necessary for the plants for their proper growth and development. The treatment combination also resulted more return from per unit area which was economically viable for poor and marginal farmers of West Bengal. It can be recommended for farming communities of West Bengal for commercial cultivation of spray chrysanthemum for optimum utilization of applied nutrients.

ACKNOWLEDGEMENT

Authors are thankful to Dean, Faculty of Horticulture, Uttar Banga Krishi Viswavidyalaya for providing the necessary facilities.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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